

Some studies

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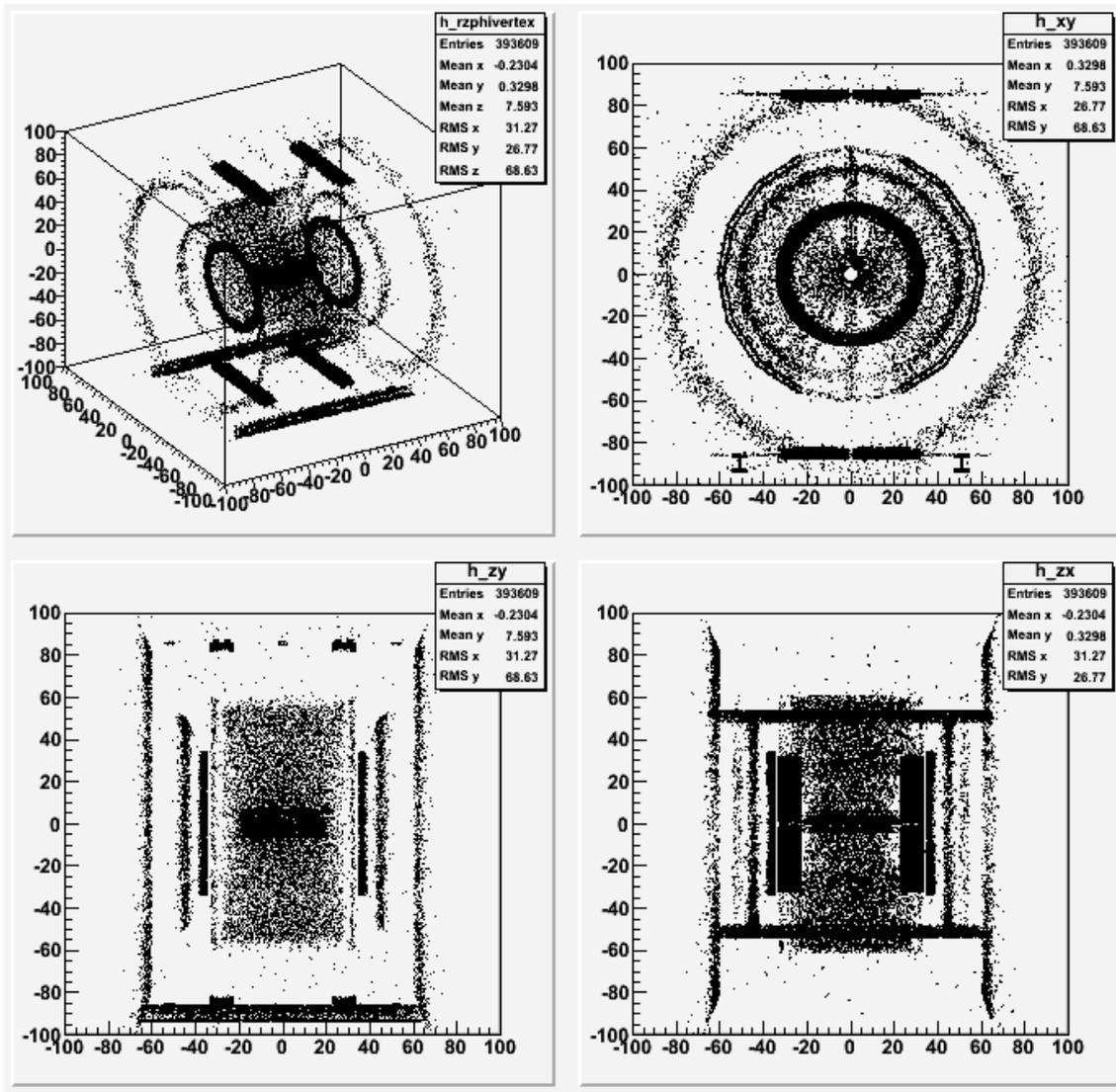
Tokyo University

Outline

1. Study on origin of conversion using simulation
2. Different approach from HbdWisClusterizer

ORIGIN OF CONVERSION

Tomography using AncHbd (PisaHit file) 1



- $\pi^0(1 M) \rightarrow \gamma\gamma, \gamma \rightarrow e^+e^-$

π^0 property

$ z $ (cm)	± 20
P (GeV/c)	0-20
$\Delta \eta$	± 0.6
$\Delta \phi$	2π

- Electrons are stored if they hit CsI
- Conversion points are plotted.
- Conversion points outside HBD is seen because of low momentum electrons.

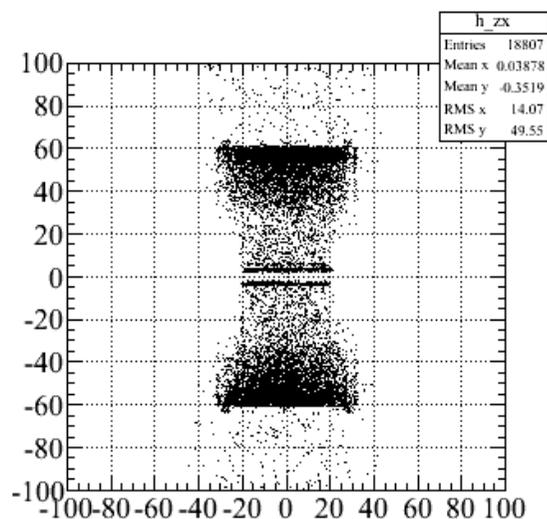
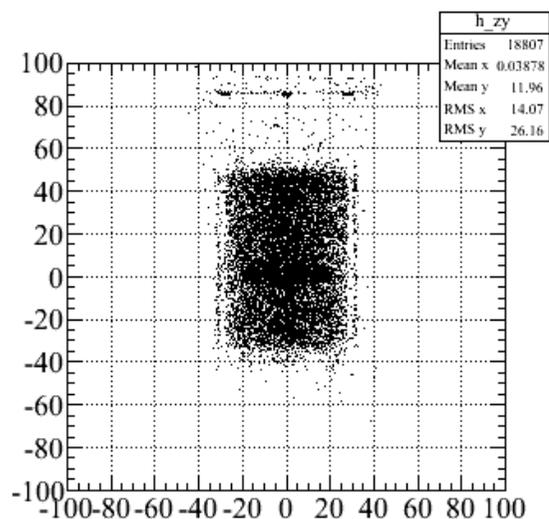
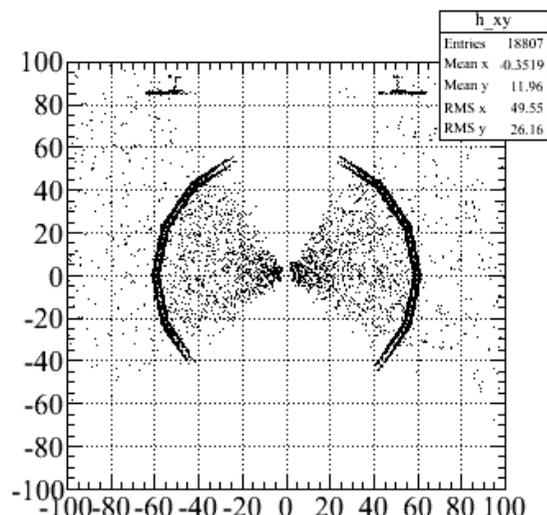
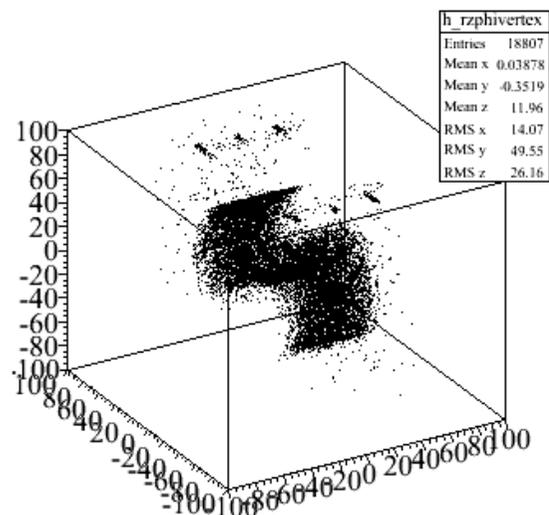
Tomography using AncHbd (PisaHit file) 2

Vertex position	R cm	ϕ deg	z cm	# of tracks
Beampipe	$R < 4$			4643
Window	$4 < R < 5.5$	$ \phi < 64, \phi > 112.5$		132
HBD window suport	$4.5 < R < 7.5$	$64 < \phi < 90$	$ z < 20$	5559
Vertical inner wall	$7 < R < 56$	$ R\cos(\phi) < 3$	$ z < 35$	1367
CF ₄	$5.5 < R < 56.7$	$ \phi < 67.5, \phi > 112.5$	$ z < 30$	10614
HBD frame	$56 < R < 65$		$30 < z < 34$	403
Reaction plane	$R < 65$		$34 < z < 50$	111419
Nose cone	$R < 100$		$40 < z < 50$	6512
HBD support top	$ R\cos(\phi) < 70$	$80 < R\sin(\phi) < 100$	$ z < 80$	137758
HBD support bottom	$ R\cos(\phi) < 70$	$-100 < R\sin(\phi) < -80$	$ z < 80$	102353
HBD Backplane	$56.7 < R < 65$	$ \phi < 67.5, \phi > 112.5$	$ z < 30$	11367
Others				1548
Total				393675

- If an electron goes through CsI twice, it is counted as two tracks.
- Number of electrons and positrons from beam pipe is consistent with calculation

$$1\text{M}(\pi^0) \times 2(\gamma) \times 2(e^+e^-) \times \frac{0.45 \cdot 2}{0.6 \cdot 2}(\Delta\eta) \times \frac{22.5 \cdot 12}{360}(\Delta\phi) \times 0.0028 \times \frac{7}{9} = 4900$$

Tomography using reconstructed tracks in CA



- Track selection & eID
 - quality=31 || 51 || 63
 - ecore/mom>0.6
 - n0>2, disp<5, chi2/npe0<10
 - |emcdphi|<0.03, |emcdz|<10
 - prob>0.01
- Origin of e reconstructed in CA

Vertex position	
Beampipe	1009
Window	29
HBD window suport	44
Vertical inner wall	0
CF ₄	2416
HBD frame	239
Reaction plane	0
Nose cone	0
HBD support top	472
HBD support bottom	0
HBD Backplane	14065
Others	991
Total	19265

Most of the electrons from reaction plane and HBD support are not reconstructed in Central Arm

Summary

- Low momentum electrons which cannot be seen by CA create signal in HBD

Vertex position	AncHbd	CA
Beampipe	4643	1009
Window	132	29
HBD window suport	5559	44
Vertical inner wall	1367	0
CF ₄	10614	2416
HBD frame	403	239
Reaction plane	111419	0
Nose cone	6512	0
HBD support top	137758	472
HBD support bottom	102353	0
HBD Backplane	11367	14065
Others	1548	991
Total	393675	19265

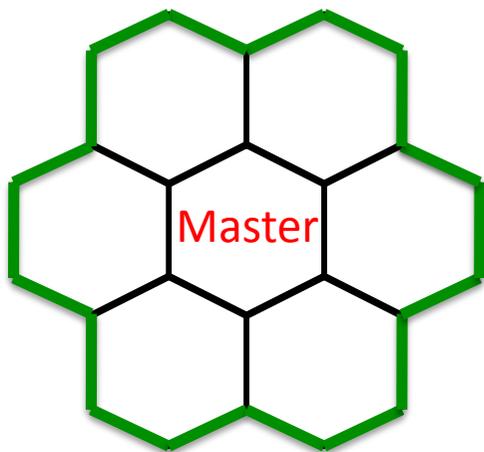
DIFFERENT APPROACH FROM HBDWISCLUSTERIZER

Idea

Current clusterizer

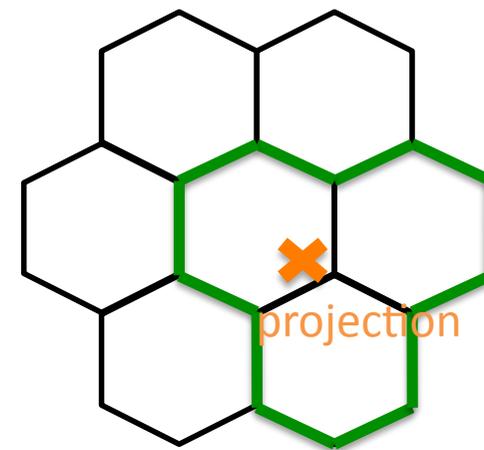
1. Find master pad (charge > 3 p.e)
2. Sum six first neighbors

There is large probability to pick up scintillation



New

1. Use CA projection points to define potential clusters

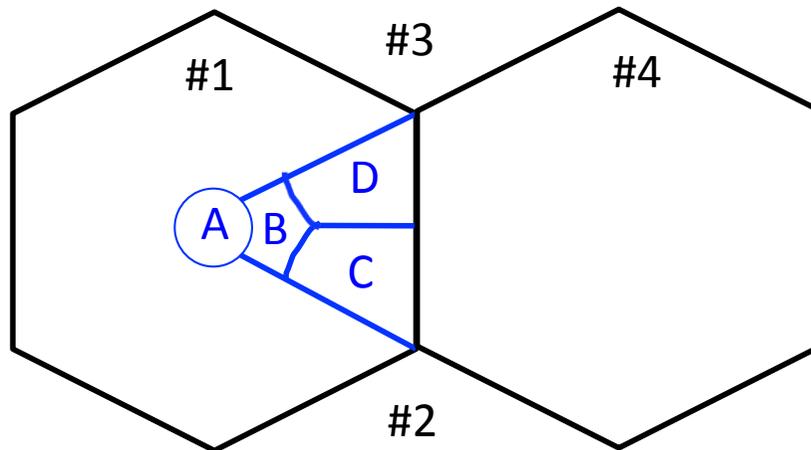


Data set

- 62GeV EWG
 - 310698, 310699, 310714, 310715, 310716, 310717
310718, 310723, 310820, 310843
- Track selection and eID in Central Arm
 - $|bbcz| < 20$
 - quality: 31 || 51 || 63
 - $n_0 > 2$, $disp < 5$, $chi^2/npe_0 < 10$
 - $dep > -0.2$, $\sqrt{emcsdphi^2 + emcsdz^2} < 3$, $prob > 0.01$
 - $|hbdpz| < 26.5$
 - Remove tracks projecting to EN2

Analysis procedure

1. Subtract the average charge per pad on event-by-event basis for each module (same as Mihael)
2. Decide which pad to look at according to projection point.



Expected cluster

- A: #1
- B: #1 and #4
- C: #1, #2 and #4
- D: #1, #3 and #4

3. Calculate “size” and “total charge”
 - “size” is defined as number of pads above threshold in the expected cluster. (Definition of threshold is shown in the next slide)
 - “total charge” is defined as sum of charge in the expected cluster
4. Use “size>0 && total charge> 6p.e” cut to select electrons.
(Forget about double rejection)

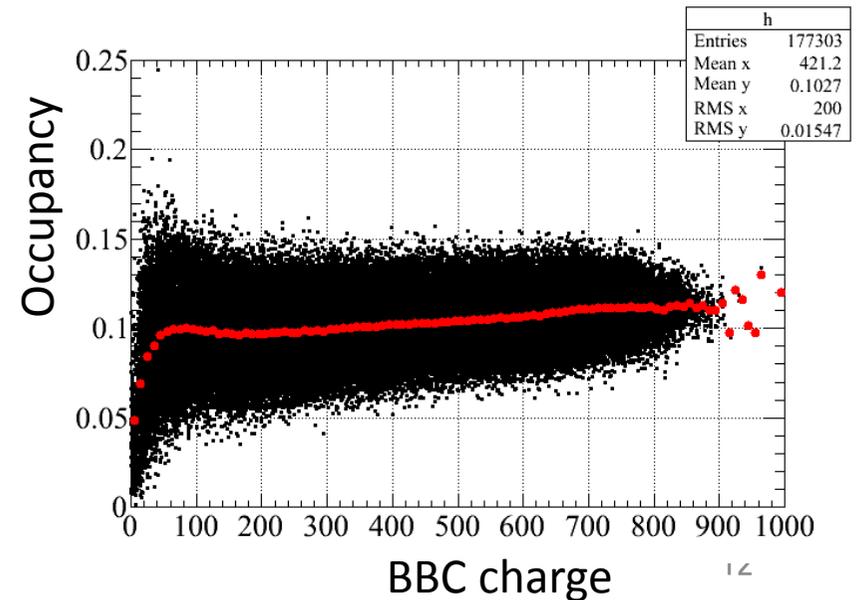
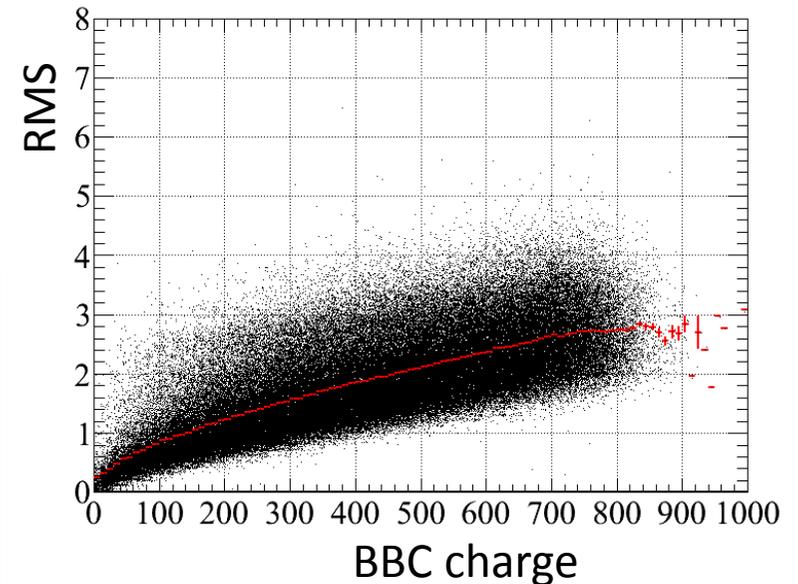
Threshold

- Define the RMS of charge per unit area:

$$\text{RMS} = \sqrt{\frac{1}{N} \sum_{Q_i > (10 + \bar{Q}) \cdot A_i} \frac{(Q_i - A_i \cdot \bar{Q})^2}{A_i}}$$

$$\left[\begin{array}{l} \bar{Q} = \text{Mean charge per unit area} \\ \quad (Q_i > (10 + \text{Mean}(\text{unit})) \cdot A_i \text{ excluded}) \\ N = \text{Number of pads} \quad A_i = \text{area of pad } i \\ Q_i = \text{charge on pad } i \end{array} \right]$$

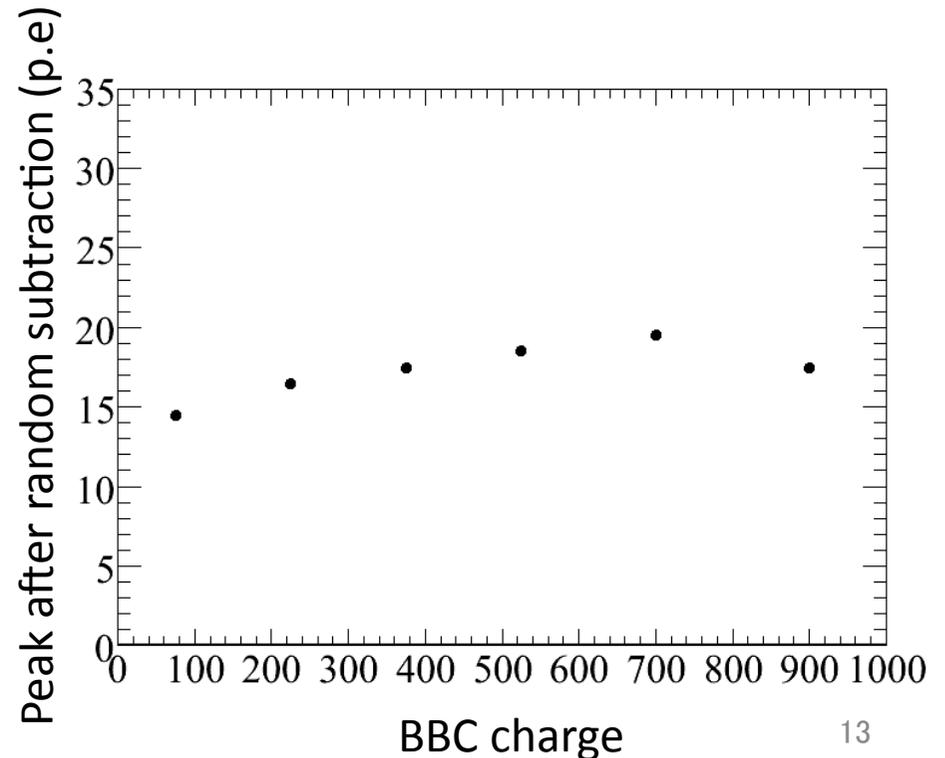
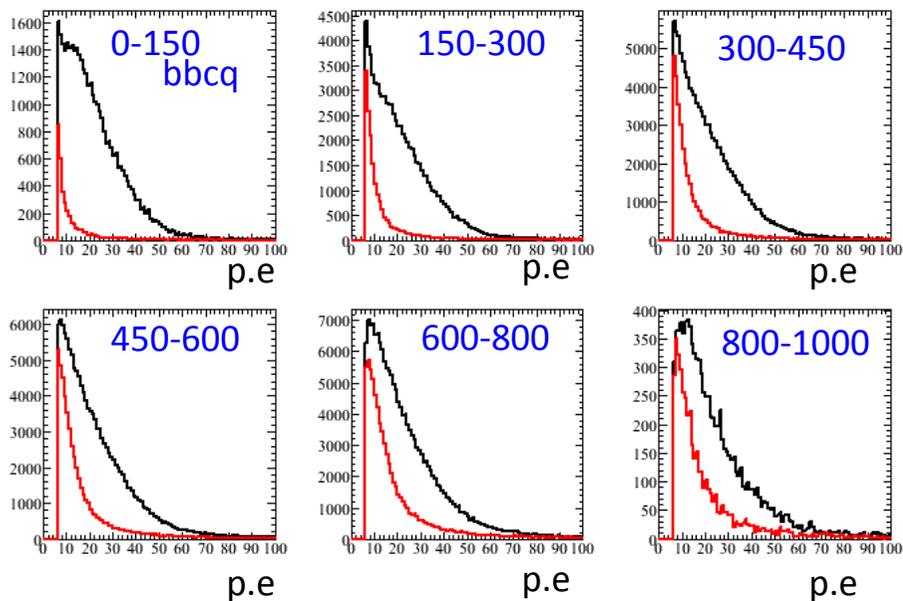
- Look at RMS as a function of bbcq
- Fit RMS mean with a 4-th order polynomial for each module.
- Define threshold as $\sqrt{A_i} \cdot \text{RMS}$
- Occupancy is $\sim 10\%$ with this threshold



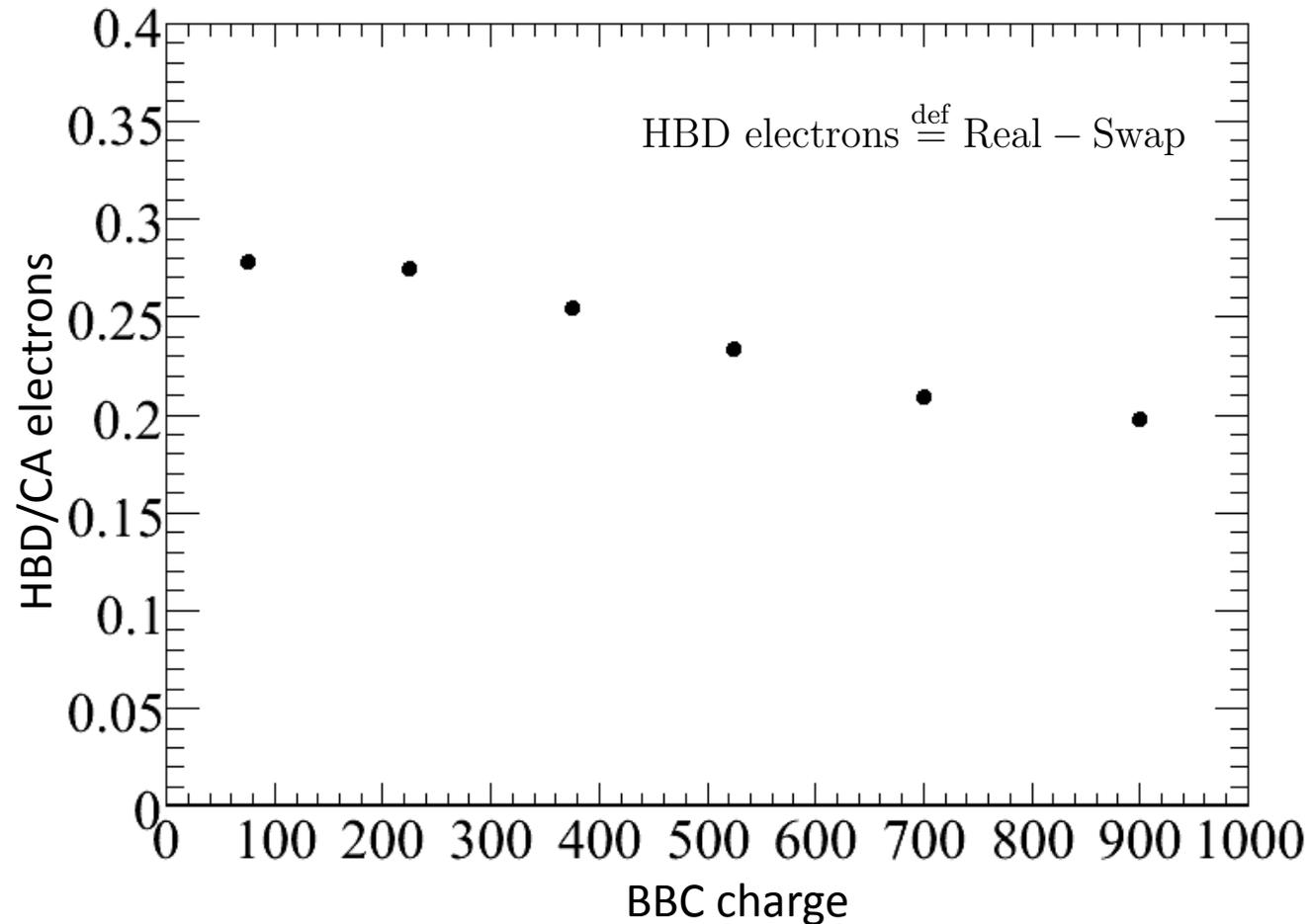
Result 1: Total charge distribution

- “size” > 0 && “total charge” > 6
- Tail of random gets larger as centrality increases.
- Peak position is smaller than the current HbdWisClusterizer because this new code uses limited number of pads.

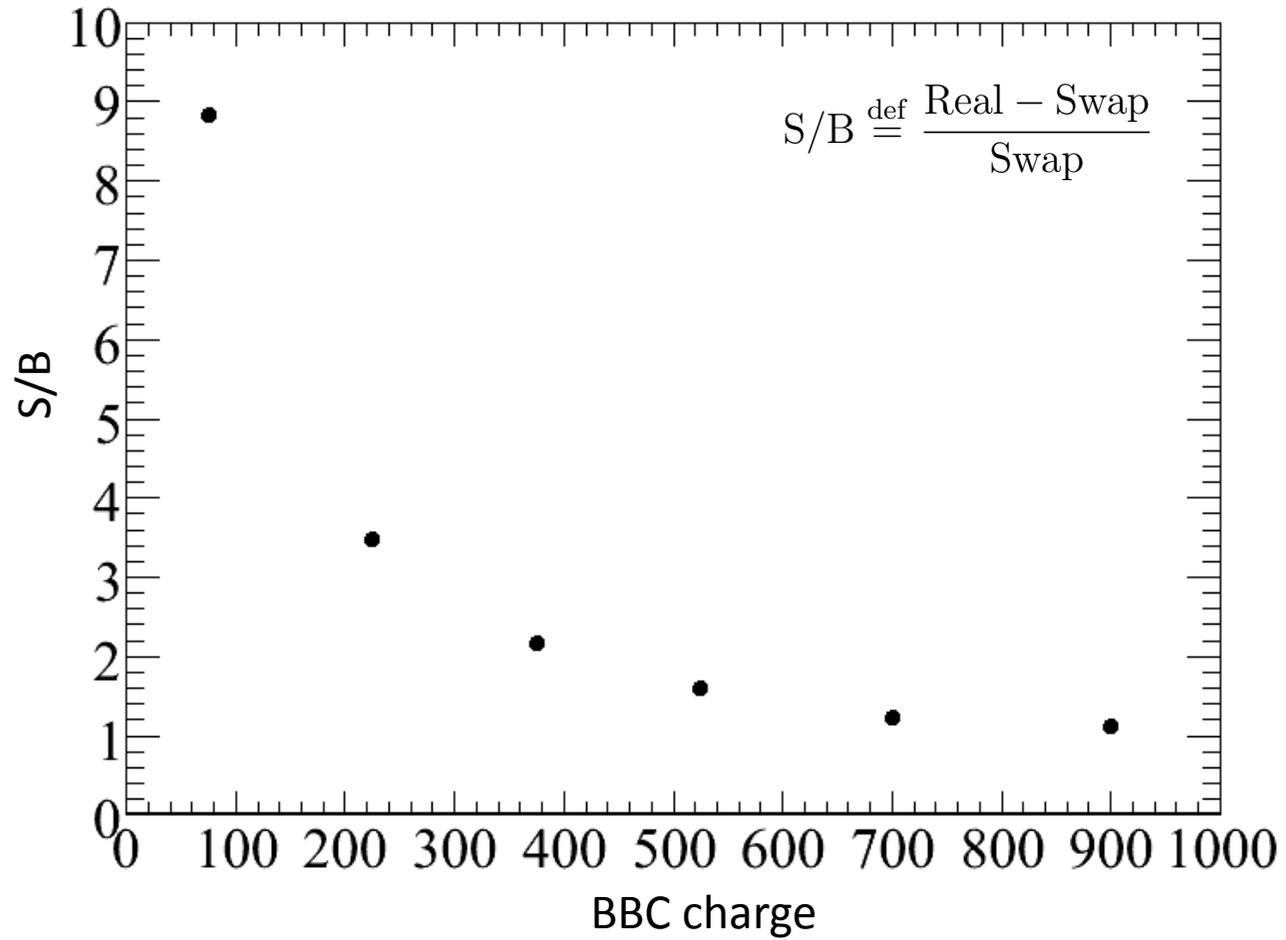
Total charge (Black: real, Red: swap)



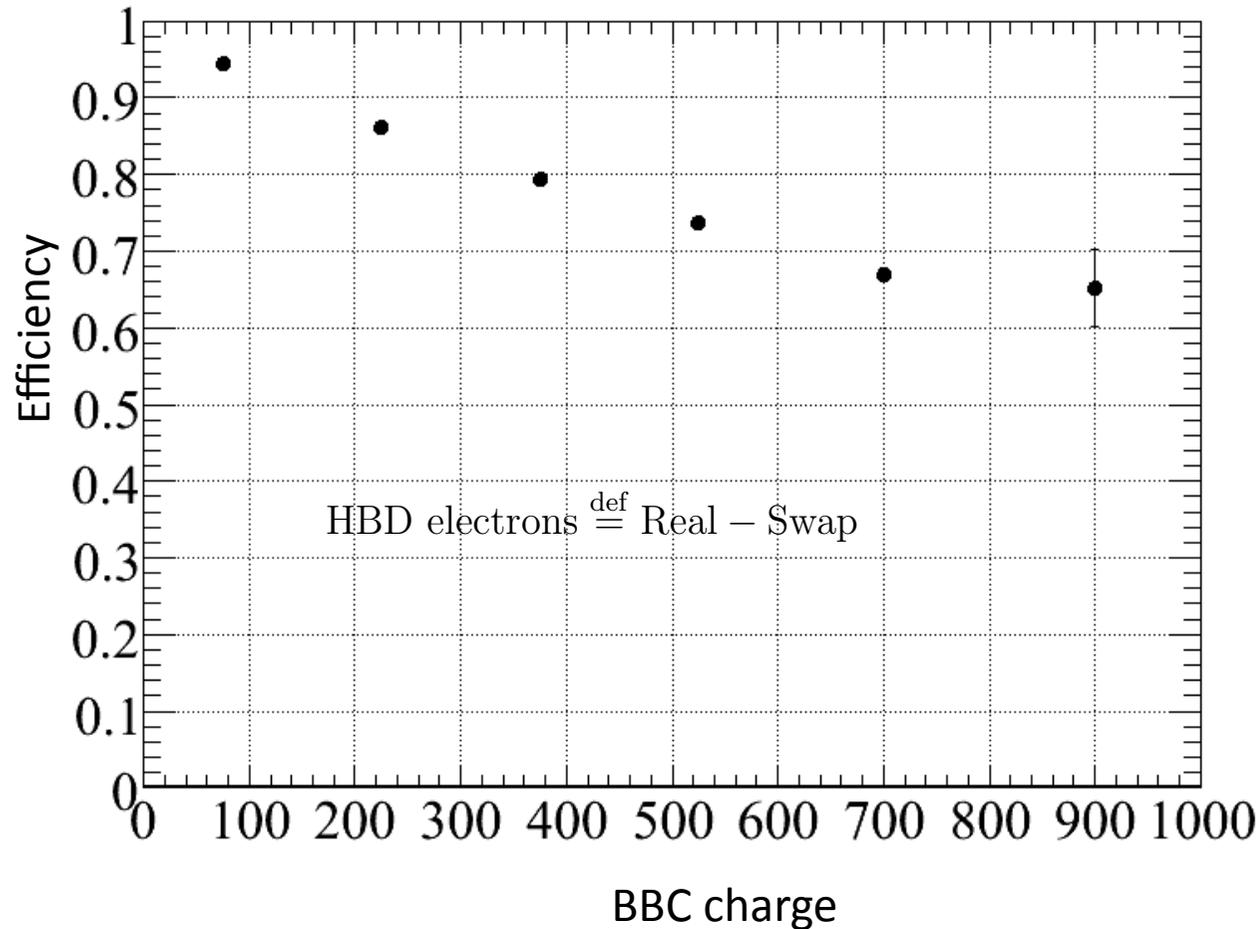
Result 2: HBD/CA electrons



Result 3: S/B



Result 4 (Single electron **simulation** embedded in data)



Single e property

$ z $ (cm)	± 20
P (GeV/c)	0-20
$\Delta \eta$	± 0.6
$\Delta \phi$	2π

Data

62GeV compact CNT

Consistent with data

- ◆ Efficiency: peripheral 0.95 -> Central 0.65
- ◆ HBD/CA electron (Result 2, data): peripheral 0.28 -> Central 0.2

Summary and outlook

- Different approach from HbdWisClusterizer is under development.
- To-do list
 - DEBUG
 - Compare the efficiency and S/B with current clusterizer quantitatively
 - Add “double” rejection
 - Tune parameters
 - Make more sophisticated look-up table (momentum dependence etc)